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SECURITY INFORMATION

INVESTIGATING COMMITTEE REPORT

OF EXPLOSION AT K-25

KS-379

Description of Damaged Property: One cold-trap type cylinder, capacity 300 lb. UF_6 at 300°F., completely destroyed.

End of water bath, 3 ft. x 4 ft. x 5 ft., knocked off.

One wooden door knocked off its hinges.

Glass in one door removed and door itself damaged.

One set of chemical balances demolished.

Damage to miscellaneous measuring instruments.

Step knocked out of expanded steel stairs and other damage done to stairs.

Hole broken in cyclone fencing.

Five window frames demolished.

Miscellaneous damage done to piping and interior walls of building.

Amount of Material Released: 123 lb. of normal UF_6.

Extent of Damage to Government Property: Estimated $2,650.

Time of Incident: 11:45 a.m., May 25, 1953.

Location of Incident: Building K-413, Carbide and Carbon Chemicals Company, K-25 Plant, Oak Ridge, Tennessee.

Description of Incident: A cylinder, presumably containing only UF_6, was placed in a hot water bath for the purpose of transferring its contents to a larger container. A few moments later, as 2 employees were connecting it to the system, they noted that the cylinder wall was expanding and ran from the building. As they reached the door, a violent explosion occurred which ruptured the cylinder, blew out the building windows, and wrecked items of equipment in the room. Other than a ruptured eardrum sustained by 1 of the employees, injuries were confined to cuts and bruises but it was necessary to remove small imbedded particles from both men. A third employee working outside the building received a cut on his head from flying debris.

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Findings:

1. The contents of several small cylinders which had been in storage since having been obtained from various locations throughout the plant over an extended period of time, were being combined in 1 large cylinder. The transfer was accomplished in the normal manner of vaporizing the UF_6 by heating the small cylinder, passing the UF_6 through a condenser, and then freezing it out again in the larger unit.
2. Ten cylinders of the same type as the one which exploded had previously been emptied in this manner.
3. According to the statements of the employees concerned as well as other evidence, the events leading up to the accident were as follows:

   a. This cylinder was the second of 2 such cylinders placed in the hot water bath.
   b. The first cylinder had not been connected to the transfer manifold, it being normal practice to place both cylinders in the bath before connecting either one.
   c. The employees were connecting the second cylinder to the manifold when they heard a small internal explosion and noted that the cylinder had expanded sufficiently to rise to the surface of the water.
   d. The 2 employees had reached the door and turned to observe the cylinder when the principal explosion occurred. Although they were knocked to the ground, they escaped from the building unaided.

4. A third employee was working about 30 ft. from the outside wall of the building. He heard the explosion and simultaneously was hit by flying debris.
5. The violence of the explosion is attested by the attached photographs which are identified as follows:

   a. Photograph No. 1. Outside of the building. The third employee was working at a point beyond the lower left edge of the photograph.
   b. Photograph No. 2. Broken windows in the interior of the building, taken from the overhead pipe gallery.
   c. Photographs Nos. 3 and 4. General views of room.
   d. Photograph No. 5. Damage done to stairway by piece of metal. Metal had broken a hole in a length of cyclone fencing before striking these stairs which were about 30 ft. from the heating bath.
   e. Photograph No. 6. Largest piece of cylinder found; it had looped itself in the insulated piping as shown.
   f. Photograph No. 7. Damage done to transfer piping. The feed bath is also shown; the cylinder which did not explode was immediately frozen down with dry ice.

6. The water in the feed bath was at a temperature of about 200°F.
7. The history of the cylinder in the plant is as follows:

   a. Prior to 1951, it was used for miscellaneous UF_6 trapping in the cascade.
   b. In September, 1951, the cylinder was decontaminated and a revised valve arrangement was welded to it.
   c. On October 1, 1951, it received a hydrostatic test at 400 psig. and an air test at 100 psig.
   d. After being stored, it was sent to the Barrier Pilot Plant in K-1401 on June 11, 1952, and was installed in a freeze-out system there on July 17, 1952.
   e. In service, the cylinder was normally kept at a temperature of about -30°F. in a mechanically refrigerated system. At one time during its use, the mechanical refrigeration system failed, but the cylinder had been valved from the remainder of the system at the time and the system temperature had been reduced with dry ice.
   f. A Beach-Russ pump using hydrocarbon oil was a part of the freeze-out system; however, a cold trap was installed between the pump and this particular cylinder.
   g. Part of the time that this cylinder was in service, it was used as a part of a system separating freon-114 and UF_6.
   h. On August 29, 1952, the cylinder was removed from the system and returned to storage with approximately 125 lb. of UF_6 reported as being contained therein.
   i. On April 28, 1953, this cylinder was one of more than a score sent to the K-413 Building for transfer of their contents to a large cylinder. This transfer procedure was also used as a part of experiments to determine the heating and cooling cycle of UF_6 in these particular containers.
   j. The transfer started on May 21, and 10 cylinders had been emptied before this unit was placed in the system.

8. The cylinder, made of 1/4-in. monel, had a rated capacity of 300 lb. of UF_6 at 300°F.
9. Calculations indicate that a pressure of approximately 1,250 psig. inside the cylinder would be necessary to produce the rupture observed.
10. Analysis of the material spread throughout the building indicated that most of the uranium found was in the tetravalent state, this indicating strong reduction of the originally hexavalent uranium. In addition, significant amounts of carbon and iron were found.
11. Although the interior of the building was heavily contaminated, no significant problem from contamination was noted outside.

Conclusions:

The committee could reach no definite conclusion of the cause of the explosion other than that it resulted from the reaction of UF_6 and some unknown substance. It is suspected that this substance was hydrocarbon

oil which had gotten into the cylinder in some way.

Recommendations:

Although it is obviously difficult to establish procedures for preventing similar incidents when the cause of the accident in question is unknown and no significant operating faults are apparent, the implementation of the following recommendations of the investigating committee appears to encompass the major practicable actions which the plant should take in attempting to prevent similar occurrences in the future:

1. In identifying the contents of UF_6 cylinders sent to storage, employees should list possible contaminants.
2. Permanent barricaded facilities should be established for transfer or sampling operations and their use should be specified for those cases where the possibility of a dangerous reaction is suspected or the employees concerned are unfamiliar with the properties of the materials being handled.
3. Locations where miscellaneous sampling throughout the plant is done should be reduced and sampling operations thus be more centralized.
4. A thorough investigation, both of the literature and by experiment if necessary, should be made of the potential explosion hazards of mixtures of materials available at K-25.
5. All systems used to fill cylinders with UF_6 should use fluorocarbon oil in their vacuum pumps rather than hydrocarbon oil.

INVESTIGATING COMMITTEE

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June 9, 1953

FIGURE NO. 1

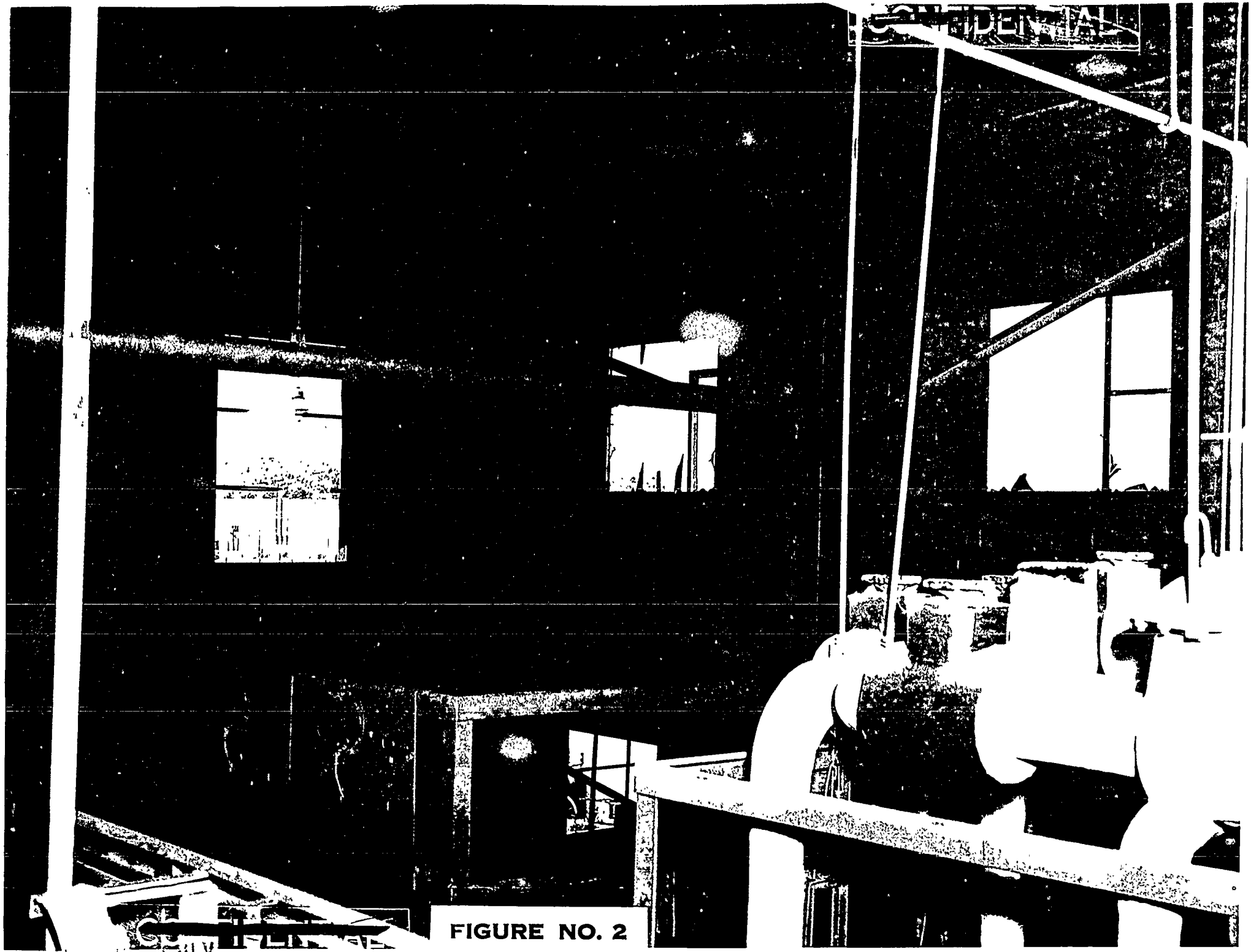

FIGURE NO. 2

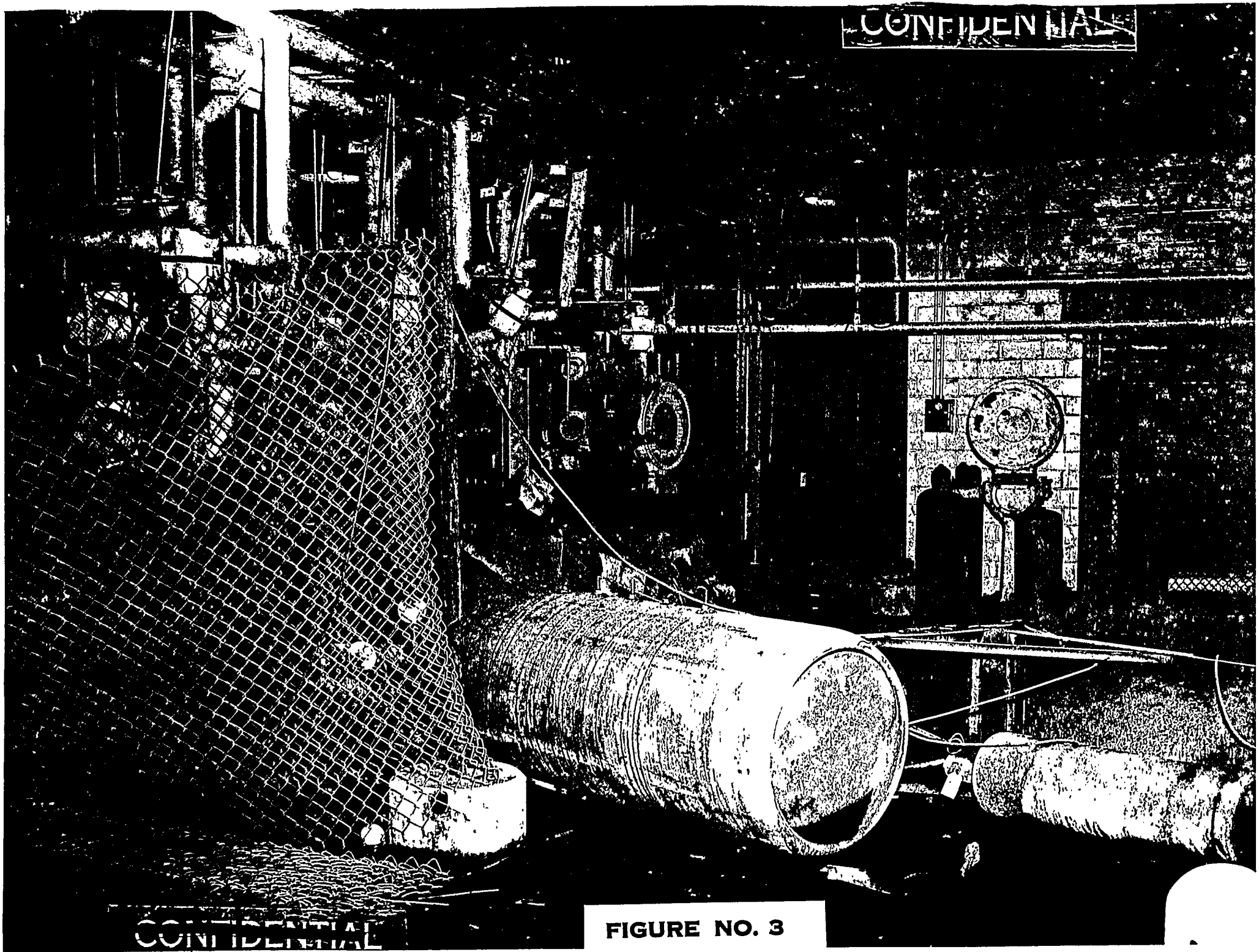

FIGURE NO. 3

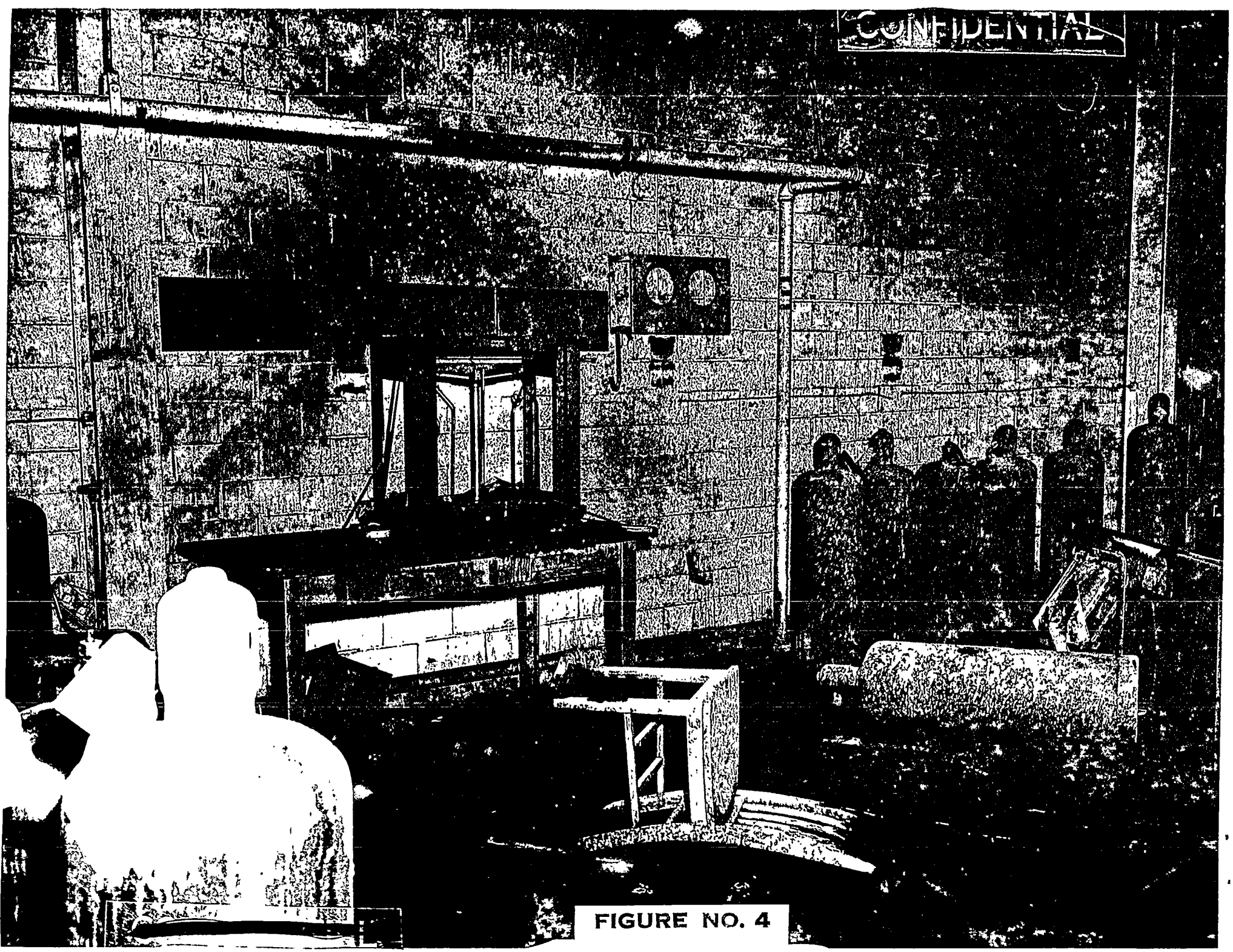

FIGURE NO. 4

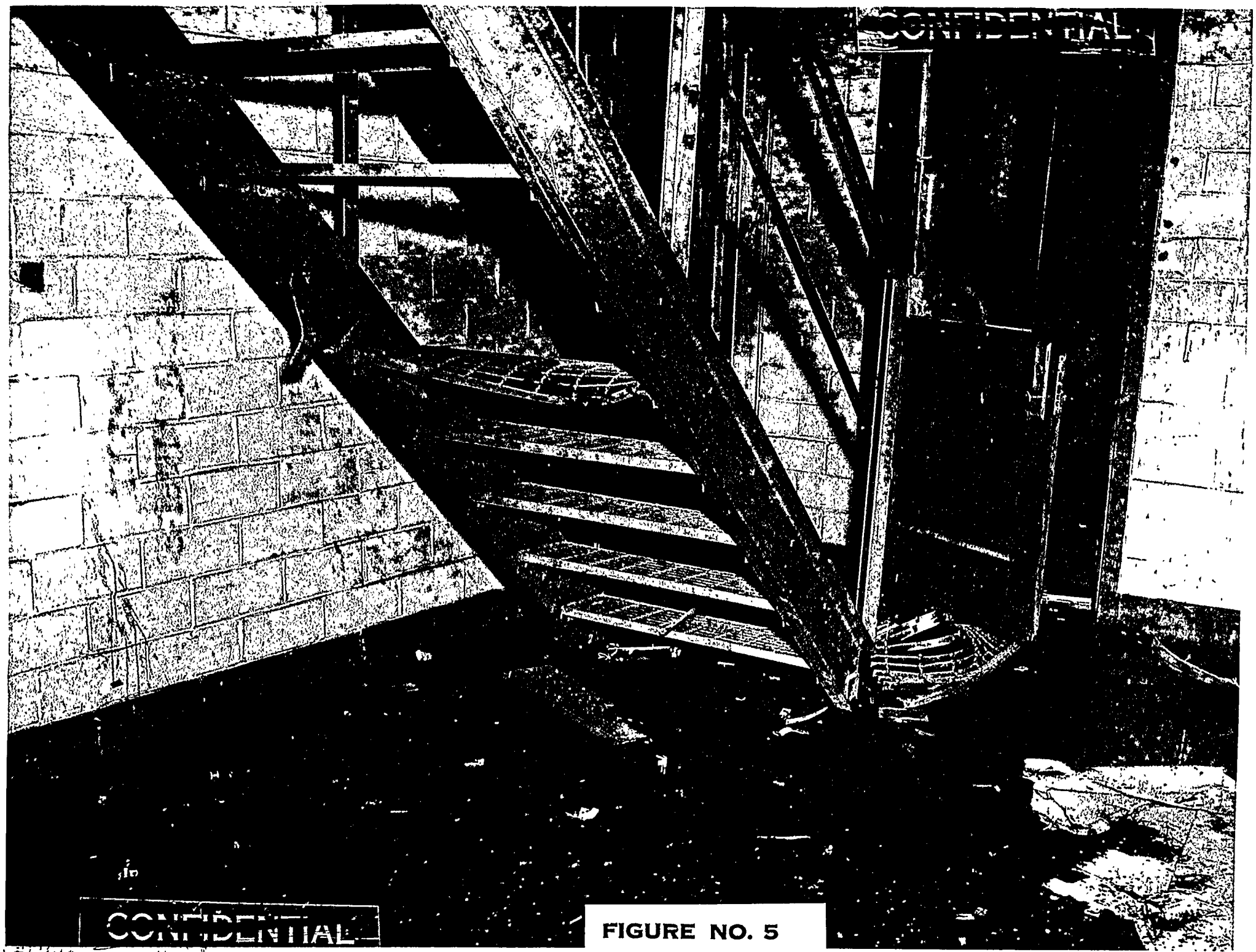

FIGURE NO. 5

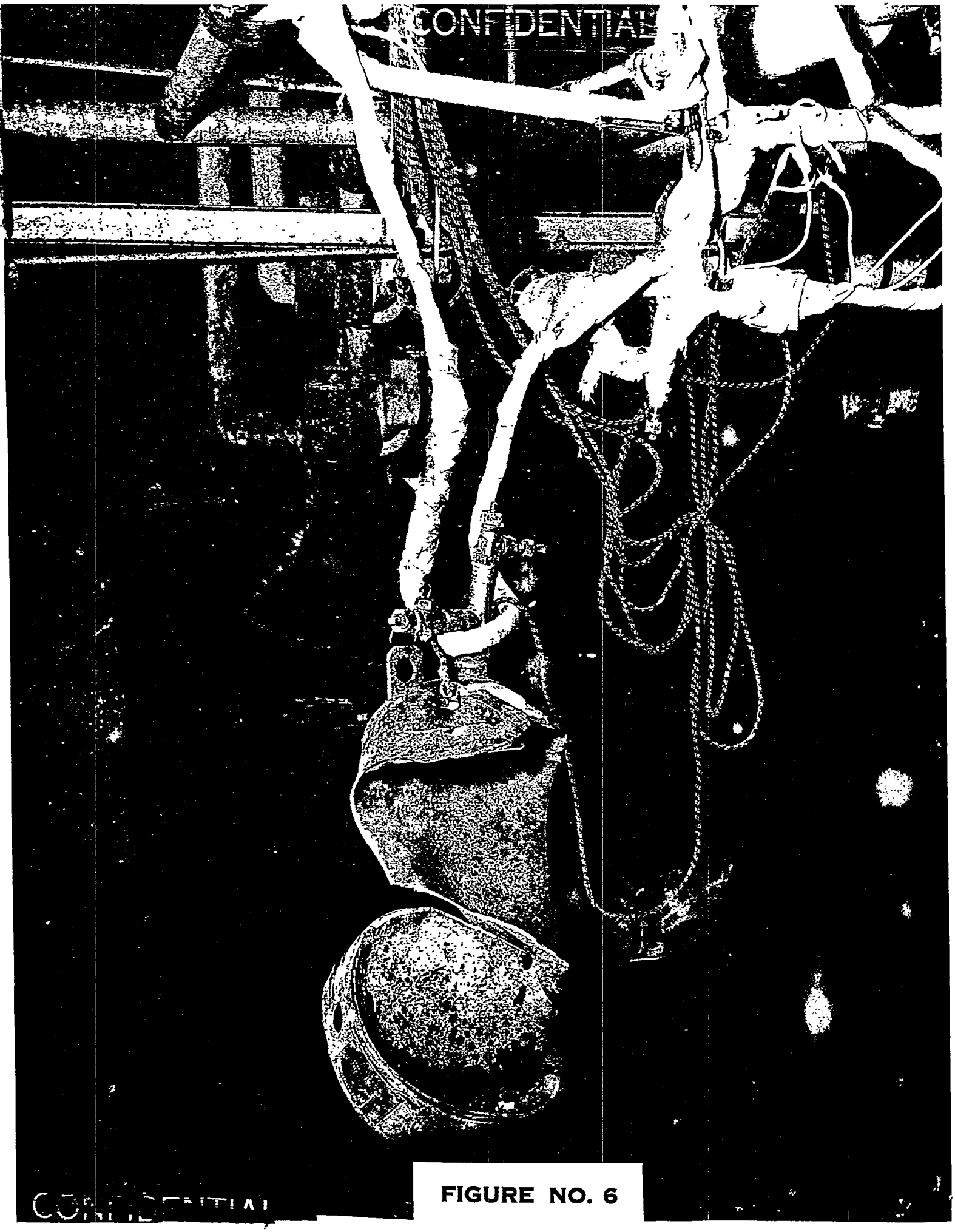

FIGURE NO. 6


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